Combined Proceedings of the Social Network Analysis and Norms for MAS Symposium - NorMAS2010 Section,
Harko Verhagen, Paul Davidsson, and Davide Grossi (Ed.), at the AISB 2010 convention, 29 March – 1 April 2010, De Montfort University, Leicester, UK

Contract Argumentation in Virtual Organizations

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Abstract. Virtual Organizations should evolve along time in order to face with unforeseen changing situations. This evolution implies the adaptation of norms, so agents must be able to consider dynamic norms in their decisions. With this aim, this paper proposes a new dialogue game protocol together with argumentation schemes for contract agreement inside dynamic organizations controlled by norms.

1 Introduction

Virtual Organizations (VOs) have been employed as an abstraction for modelling open agent societies. They include the integration of both the organizational and individual perspectives and also the dynamic adaptation of models to organizational and environmental changes [4]. In this way, it is necessary to detect situations of interest and to manage them maximising the adaptation flexibility and capacity. The organization adaptation affects to, among other aspects, its norms, agreements, commitments and topologic structure.

Taking into account the challenges and difficulties arisen by the dynamic adaptation of VOs, our proposal consists of a new dialogue game protocol and the adaptation of previous argumentation schemes in order to allow agents to reach agreements considering the existence of dynamic norms which control their behaviours.

This paper is structured as follows: Section 2 provides a theoretical definition of VO together with a model of norms for controlling agents belonging to VOs. Section 3 describes the proposed argumentation schemes for contract agreement. This argumentation protocol has been applied into a case-study in Section 4. Finally, a discussion of related proposals and future works are shown.

2 Virtual Organization Model

A VO is formally defined in [3] as follows:

Definition 1 (Virtual Organization)**.** *A Virtual Organization (VO) is defined as a tuple* $VO = \langle Ag, Ro, Roles, \leq_{prior}, OU, N, Se, ER, Act, Cap, Des, Prob \rangle$ *where:*

- Ag *is the set of agents which are the members of the* VO*.*
- Ro *is the set of roles which have been defined in the* VO*.*
- $Roles : Ag \rightarrow 2^R$ *is a function that matches an agent with the set of roles which it is currently playing.*
- $\leq_{prior}$ *is a total order relationship which expresses priority among roles.*
- $OU = \{ou_0, ou_1, ...\}$ *is the set of organizational units which have been defined in the* VO*, where each* $ou_i \subseteq (Ag \cup OU)$*.*
- N *is the normative context of the* VO*, i.e. the set of norms that control the operations carried out in the* VO*.*
- S *is the set of services defined inside the* VO*.*
- ER *is the set of resources located in the* VO *environment.*
- Act *is a set of first order atomic formulae which represent primary individual actions. These actions include the request and provision of services and the perception and access to the environmental resources.*
- $Cap : Ag \rightarrow 2^{Act}$ *is a function which maps each agent with actions it is able to perform.*
- $Des : Act \rightarrow [-1, 1]$ *is a function that assigns a real value for representing desirability/undesirability of actions.*
- $Prob : Act \rightarrow [0, 1]$ *is a function that assigns a probability to an action occurrence.*

Due to space reasons, other features of the VO model, such as dynamicity, have not been described here. However, this theoretical definition of a VO allows defining: i) the *Structural* dimension ; ii) the *Functional* dimension ; iii) the *Environmental* dimension ; and (iv) The *Normative Context* (N). Next, a complete definition of the normative context is provided.

2.1 Normative Model

In this work norms are classified into two main levels according to the norm scope:

Definition 2 (Normative Context)**.** *The set of norms of a* VO *is defined as* $N = IN \cup CN$ *where:*

- IN *are the institutional norms which have been explicitly promulgated by the institution; their violation is considered as an illicit act and it might lead to institutional sanctions.*
- CN *are norms derived as a consequence of an interaction among agents*

Definition 3 (Institutional Norm)**.** *An institutional norm* ($n_i \in IN$) *is defined as* $n_i = \langle D, C, T, S, E \rangle$ *where:*

- $D \in \{O, F\}$*; being* O *and* F *deontic operators for representing obligations (*O*) and prohibitions (*F*), respectively.*
- $C \in Act$ *is a formula that represents the action that must be carried out in case of obligations; or that has to be avoided in case of prohibitions.*
- $T \in Ro$ *is the target of the norm; i.e. the role affected by the norm.*

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- $S \in Act$ *is an expression which describes the action that will be carried out as sanction in case of norm violation.*
- $E \in Act$ *represents the norm expiration action.*

For simplicity, norms in our model have not an activation condition. Thus, they are always active until the expiration action holds. Moreover, norms have been defined as a deontic control over a single action. However, this work can be extended for considering a more complex notion of norms.

Semantics of an institutional norm depends on the concrete deontic type. For example semantics of an institutional obligation is defined as follows:

$$\langle O, C, T, S, E\rangle \equiv \forall a \in Ag : T \in Roles(a) :$$

$$(Do_a(C) \rightarrow \mathcal{F})\mathcal{U}(E \wedge (\neg\mathcal{F} \rightarrow Do_{Institution}(S)))$$

$\mathcal{U}$ is the temporal binary operator $\mathcal{U}$ntil and $\mathcal{F}$ is the norm fulfilment proposition. $Do_a(C)$ is the predicate for representing an agent a carrying out action C. Therefore, after the promulgation of the norm, the performance of the norm condition by an agent which is affected by the norm $(a \in Ag : T \in Roles(a))$ implies the fulfilment of the norm $(Do_a(C) \rightarrow \mathcal{F})$. Once the norm is deactivated (E), sanction is performed by the institution if the norm has not been fulfilled $(\neg\mathcal{F} \rightarrow Do_{Institution}(S))$.

Contract Norms (CN) are normative prescriptions that emerge as a result of the interaction among agents. Therefore, this level of norms is formed by the contracts reached by agents along their execution.

Definition 4 (Contract)**.** *A contract $(n_c \in CN)$ is defined as $n_c = \langle D, C, a, b, S, R, E\rangle$ where:*

- $D \in \{O, F\}$ *represents the deontic type of the contract.*
- $C \in Act$ *is the previously defined norm condition.*
- $a, b \in Ag$ *are the contract addressee and beneficiary agents, respectively.*
- $S, R \in Act$ *are expressions which describe the actions that will be carried out in case of contract violation or fulfilment, respectively.*
- $E \in Act$ *represents the norm expiration action.*

Semantics of contracts also depends on the concrete deontic type. For example, semantics of a prohibition contract is defined as follows:

$$\langle F, C, a, b, S, R, E\rangle \equiv$$

$$(Do_a(C) \rightarrow \mathcal{V})\, \mathcal{U}\, (E \wedge (\neg\mathcal{V} \rightarrow Do_b(R)) \wedge (\mathcal{V} \rightarrow Do_b(S)))$$

$\mathcal{V}$ is the violation proposition. Thus, after the contract creation, occurrence of the condition implies a violation $(Do_a(C) \rightarrow \mathcal{V})$. Once the contract expires, violations will be sanctioned and contract fulfilment will be rewarded $(E \wedge (\neg\mathcal{V} \rightarrow Do_b(R)) \wedge (\mathcal{V} \rightarrow Do_b(S))$.

2.2 Norm Conflicts

Our proposal takes as a reference the work on norm conflict detection and resolution described in [9]. In this work they define substitutions as:

Definition 5 (Substitution)**.** *A substitution σ is a finite and possibly empty set of pairs x/y where x is a variable and y is a term.*

The application of a substitution is defined as:

1. $c \cdot \sigma = c$ if c is a constant.
2. $x \cdot \sigma = y \cdot \sigma$ if $x/y \in \sigma$; otherwise $x \cdot \sigma = x$.
3. $p^n(\rho_0, ..., \rho_n) \cdot \sigma = p^n(\rho_0 \cdot \sigma, ..., \rho_n \cdot \sigma)$, where p^n is a n-ary predicate symbol.

Then the unification relationship is defined as follows:

Definition 6 (Unification)**.** *The $unify(C, C')$ relationship holds iff there is a possibly empty substitution σ such that $C \cdot \sigma = C' \cdot \sigma$.*

Taking these previous definitions as a reference, we define the notion of norm conflict in our model. In our proposal a norm conflict can be an *Institutional Conflict* or a *Contract Conflict*. Next, each type of norm conflict is formally defined.

Definition 7 (Institutional Conflict)**.** *Any contract $n_c = \langle D, C, a, b, S, R, E\rangle$ is in conflict ($IC(n_c, n_i')$) with an institutional norm $n_i' = \langle D', C', T', S', E'\rangle$ if: i) they define opposite deontic constraints $D \neq D'$; ii) over the same action $unify(C, C')$; iii) the contract is addressed to an agent which plays the norm target role ($T' \in Roles(a)$); and iv) the institutional norm is active ($\neg E'$).*

Definition 8 (Contract Conflict)**.** *A contract $n_c = \langle D, C, a, b, S, R, E\rangle$ is in conflict ($CC(n_c, n_c')$) with a previous contract $n_c' = \langle D', C', a', b', S', R', E'\rangle$ if: i) they define opposite deontic constraints $D \neq D'$; ii) over the same action $unify(C, C')$; iii) both contracts are addressed to the same agent $a = a'$; and iv) the previous contract is active ($\neg E'$).*

3 Argumentation For Contract Agreement

Our main objective in this research is to solve a problem of contract agreement. In our initial settings we have two agents $i, j \in Ag$ that want to reach an agreement over the acceptance of a particular contract. Therefore, the *proponent* agent i has to persuade the *opponent* agent j to accept a contract $n_c \in CN : n_c = \langle D, C, j, i, S, R, E\rangle$. Thus, the proponent agent i starts a dialogue with the opponent agent j and proposes it norm n_c. In this section, we show the type of arguments and attacks to these arguments that agents can interchange during the dialogue in the context of our normative model. Then, we propose a dialogue game protocol that controls the agents' interaction. The study of the internal preferences of agents, their reputation and the trust that they have in other agents are out of the scope of this work. Here we have focused on defining the type of arguments and attacks that agents can put forward and the rules of the dialogue that manage the interchange of these arguments and attacks in the normative model proposed.

3.1 Initial Arguments

Following our normative model, the opponent agent j could have several possible types of arguments to reject the acceptance of norm n_c:

A1: There is an institutional norm $n_i' \in IN, n_i' = \langle D', C, T', S', E'\rangle$ which is in conflict with n_c (i.e. $IC(n_c, n_i')$).

A2: There is a previous contract agreement by which agent j accepted a contract $n'_c \in CN, n'_c = \langle D', C', j, k, S', R', E' \rangle$ which is in conflict with n_c (i.e. $CC(n_c, n'_c)$).
A3: There is a lack of interest in the reward awarded for the acceptance of this norm (i.e. $Des(R) == 0$), but the opponent specifies in what case it would be interested in the reward (R') so as to accept n_c.
A4: There is a lack of interest in the reward awarded for the acceptance of this norm (i.e. $Des(R) == 0$).
A5: Agent j cannot accept norm n'_c since it has no capabilities to fulfil this norm (i.e. $C \notin Cap(j)$).

Some of these arguments fit stereotyped patterns of human reasoning that argumentation theory has modelled as *Argumentation Schemes* [10]. Concretely, arguments A1 and A2 fit the normative version of the *Argument from Oppositions* scheme. The scheme has the following structure:

Major Premise: If X receives the evaluation W', X cannot receive the opposite evaluation W at the same time and in the same respect.
Minor Premise: X receives the evaluation W'.
Conclusion: X cannot receive the opposite evaluation W at the same time and in the same respect.

Then, if we adapt this scheme to our settings, we have that:

Scheme 1. "If the opponent agent j accepts the norm n', with $n' \in \{n'_c, n'_i\}$, agent j cannot accept the conflicting norm n_c at the same time and at the same respect".

Thus, if agent j receives n_c and at the same time has an institutional norm n'_i or a previous contract n'_c that conflicts with n_c, agent j can conclude that it cannot accept n_c.

If the opponent agent rejects norm n_c due to argument A3, it initially rejects the norm but provides the proponent with an alternative. This alternative would consist of a condition that, if fulfilled by the proponent, the opponent would accept norm n_c. In this case, the argument fits the structure of the *Two Person Practical Reasoning* scheme:

Major Premise: X intends to realize A, and tells Y this.
Minor Premise: As Y sees the situation, B is a necessary (sufficient) condition for carrying out A, and Y tells X this.
Conclusion: Therefore, X should carry out B, unless he has better reasons not to.

Adapting this scheme to our settings, it is reformulated as:

Scheme 2. "Agent i intends to realize contract n_c and tells agent j this. As j sees the situation, offering a new reward R' is a necessary condition for carrying out contract n_c, and j tells i this. Therefore, i should offer a new reward R', unless it has better reasons not to".

Thus, with this argument the opponent agent points out the proponent a possible way of persuading it and carrying on with the dialogue. Also, this scheme has a set of *Critical Questions* (CQ) associated [10]. These questions are stereotyped ways of attacking the conclusion of the argument and they will be analysed in the next section.

Finally, by default we assume that the preferences and capabilities of an agent do not change during the dialogue (but they can change when the dialogue finishes). Therefore, A4 and A5 are indisputable arguments that end the dialogue.

3.2 Attacks

Depending on the type of argument that the opponent agent has for rejecting the acceptance of contract n_c, the proponent agent still has the opportunity of trying to persuade it to accept it. This is the case of arguments of types A1, A2 and A3. On the opposite, if the opponent did not provide the proponent with any alternative way of accepting norm n_c in A5 or it rejected the norm by putting forward A4, these arguments are considered indisputable and the dialogue will end here. Thus, arguments A1, A2 and A3 admit replies (i.e. attacks) from the proponent.

In the case of A1 and A2, the *Argument from Oppositions* scheme does not have associated critical questions. However, it can be still attacked if the proponent agent thinks that there is an exception to its conclusion. This exception poses a new argument for not paying attention to the conflict between norms and the proponent could send it to the opponent, trying again to persuade it to accept norm n_c. This pattern of reasoning fits the *Argument For an Exceptional Case*:

Major Premise: If the case of x is an exception, then the established rule can be waived in the case of x.
Minor Premise: The case of a is an exception.
Conclusion: Therefore, the established rule can be waived in the case of a.

Adapting this scheme to our settings, we have that:

Scheme 3. "If the case of A1 (A2) is an exception, then the conclusion of the *Argument From Oppositions* scheme can be waived in the case of A1 (A2). Thus, if we have that A1 (A2) are exceptions to the established rule, then the conclusion of the *Argument From Oppositions* scheme can be waived".

In the context of our normative model, possible exceptions to A1 are:

E1: The desirability of reward for fulfilling the contract n_c is greater than the undesirability of the sanction applied for the non-fulfilment of the institutional norm n'_i (i.e $Des(R) + Des(S') > 0$).
E2: Actually, the sanction associated for the non-fulfilment of the conflicting institutional norm n'_i is never applied (i.e. $Prob(S) = 0$).

Also, possible exceptions to A2 are:

E3: The reward for fulfilling the contract n_c is greater that the sanction and the lost of reward implied by non-fulfilment of the contract n'_c (i.e. $Des(R) > Res(R') - Des(S')$).
E4: The role r_i of the proponent agent i has more priority than the role r_k of the agent k that agreed the previous contract (and its associated norm n'_c) with the opponent agent (i.e. $\exists r_i \in Roles(i) : \forall r_k \in Roles(k) : r_i \geq_{prior} r_k$).

If the proponent agent attacks the argument A1 or A2 of the opponent agent by putting forward the conclusion of the *Argument for an Exceptional Case*, the opponent can surrender to the attack and accept the norm n_c or else it can reject again the norm. A possible way of rejecting this attack could be to pose one of the critical questions of the scheme. If we adapt these questions to our normative model we have

the following possible defeats[2]:

CQ1: Can evidence that the conclusion of the *Argument From Oppositions* scheme does not apply to this case be given?

We have modelled possible attacks to the possible exceptions by adapting the type of attack defined in the CQ1. Thus, the opponent can attack exceptions by requesting the proponent to show evidence for the exception. Then, even if the proponent shows evidence for the exceptions, the opponent could still reject the norm. Possible reasons could be, for instance, if it does not agree with (or believe) the evidence provided by the proponent, if it prefers observing the institutional norms, no matter how many times sanctions are applied or what the reward for fulfilling contracts is or if it has another argument of the type explained in the previous section to reject again the norm.

Finally, the proponent agent could attack argument A3. In this argument, the opponent is willing to accept norm n_c with the condition that the proponent offers a new reward R', following the conclusion of the *Two Person Practical Reasoning* scheme. We assume that offering a new reward R' is the only condition that the opponent puts for accepting contract n_c. Thus, if the proponent agent decides not to offer a new reward, it just rejects A3 without giving alternatives for dispute. However, if it finally agrees to change the reward of the norm, it proposes again the new norm $n'_c \in IN, n'_c = \langle D, C, j, b, S, R', E\rangle$ to the opponent.

3.3 Dialogue Game Protocol for Contract Agreement

Following the approach of [8], we have modelled the agents' dialogue by means of a formal dialogue game for contract agreement that allows agents to reason about argumentation schemes. The protocol assumes the existence of a proponent agent i that tries to agree a contract $n_c \in CN$ with an opponent agent j. The interaction protocol between the agents of the network has been modelled with the components for dialogue games identified by McBurney and Parsons in [5]. The rules of the protocol are founded in the logic patterns of reasoning that agents could follow in a situation like this.

- Commencement Rules: The dialogue starts when the proponent agent i sends to the opponent agent j a proposal for the acceptance of a new contract n_c. Then, j receives the proposal and has to make a decision on whether accepting the norm or rejecting it.
- Locutions:
  - Statements: they are the permissible locutions in the dialogue and their compounds (*propose*(*norm*), *accept*, *reject* and *assert*(*argument*)). Arguments can be arguments of the type described in section 3.1, information about norms or evidences of the type shown in section 3.2, depending on the stage of the dialogue when this locution is stated.
  - Withdrawals: *noCommit*() is the locution that agents use when they cannot answer the locution that they have received. In the case of the proponent, it withdraws its proposal and ends the dialogue. In the case of the opponent, it withdraws its last argument for rejecting the norm and either rejects it again (due to a different reason), accepts it or ends the dialogue. Also, this locution is used when the opponent does not want (or cannot) provide an answer to the proponent, but still does not accept the contract norm.
  - Questions: the locution *assert*(*norm*)? asks the opponent agent for information about the previous contract that conflicts with the proposed norm. Agents are not committed to answer questions. Thus, the opponent agent is not committed to give any information about its norms to the proponent.
  - Attacks: the locution *pose*(*exception*) poses an attack to the argument of the type A1 and A2.
  - Challenges: *why*(*locution*)?, where locution can be a rejection or an exception attack, requests arguments that support them.
- Commitment Rules:
  - The assertion of the locution *propose*(*norm*) commits the proponent and the opponent to observe the rules of the dialogue game.
  - The assertion of the locution *noCommit*() by the proponent, withdraws its proposal and ends the dialogue.
  - The assertion of the locution *noCommit*() by the opponent, withdraws its last argument for rejecting the norm (if any).
  - The assertion of the locution *why*(*locution*)? commits the recipient either to provide an argument for the rejection or the attack or else, to withdraw it.
- Dialogue Rules: The rules of the game define which are the allowed locutions in each step of the dialogue. Figure 1 shows the sequence diagram that provides a graphical representation of the dialogue. In this figure, objects represent steps and arrows represent transitions between steps, which are labelled with the associated locution.

  R1: The proponent agent opens the contract agreement process proposing the acceptance of the contract norm n_c to the opponent (*propose*(n_c)).

  R2: The opponent agent can *accept* the contract and end the dialogue, end the dialogue without providing an answer (*noCommit*()) or reject the contract norm (*reject*).

  R3: The proponent can either withdraw its proposal and end the dialogue (*noCommit*()) or ask the opponent for providing an argument for the rejection of the contract (*why*(*reject*)?).

  R4: The opponent agent can either withdraw the rejection and come back to R2 (*noCommit*()) or *assert* an argument (i.e. A1, A2, A3,A4 or A5) that supports the rejection of the contract norm.

  R5: The proponent agent can either withdraw its proposal (*noCommit*()) and end the dialogue or *pose* an attack with exceptions E1 or E2.

  R6: The proponent agent can either withdraw its proposal (*noCommit*()) and end the dialogue or it can

[2] The original definition of the critical questions is available at [10]

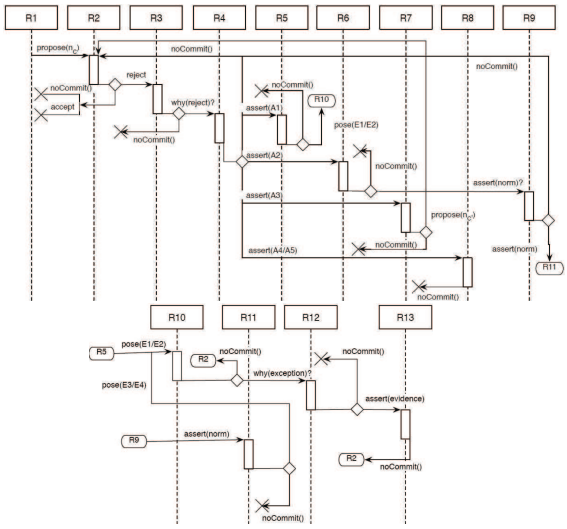

Figure 1. Sequence Diagram of the Interaction Protocol

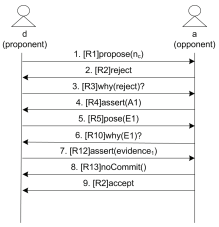

Figure 2. Case-Study Dialogue

ask the opponent for more information about its contract n'_c that conflicts with the proposed contract norm. ($assert(norm)$?) By default, the proponent does not have any information about the sanction of this norm or the role of the agent that enacted it, which are necessary information to pose exceptions E3 or E4.

R7: The proponent agent can either withdraw its proposal ($noCommit()$) and end the dialogue or make a new proposal n'_c with the new reward R' ($propose(n'_c)$).

R8: The proponent agent has to withdraw its proposal and end the dialogue, since the opponent does not give any chance for dispute.

R9: The opponent agent can either withdraw the rejection and come back to R2 or provide the proponent with information about its previous contract that conflicts with the proposed contract norm ($assert(norm)$).

R10: The opponent agent can either withdraw the rejection and come back to R2 or ask the proponent for providing an argument for the exception attack received ($why(exception)$?).

R11: The proponent agent can either withdraw its proposal and end the dialogue or *pose* an attack with exceptions E3 or E4, coming back to R10.

R12: The proponent agent can either withdraw its proposal and end the dialogue or provide the opponent with an evidence that supports the exception attack that it posed ($assert(evidences)$).

R13: The opponent agent withdraws its rejection and comes back to R2.

- Termination Rules: The dialogue ends either when the opponent agent accepts the contract norm proposed by the proponent agent or when the proponent agent withdraws its proposal. In addition, both agents can end the dialogue in any moment without reaching an agreement about the contract by putting forward a $noCommit()$ locution. However, the opponent agent also uses this locution to withdraw the last argument that it provided for rejecting the norm and reject it with any other argument. To avoid infinite dialogues, the opponent agent is not allowed to use the same argument for rejecting the contract twice. Also, after a maximum time is exceeded, the dialogue ends without reaching to a contract agreement.

This proposal has been applied into a case study in the following section.

4 Case Study: the m-Water Domain

The management of water in a basin is a challenge of significant social relevance which can be seen as a VO. In this sense, *irrigators* which belong to the same area of a basin can be organized forming VOs or *irrigator communities*. These communities act on behalf of their members by defending their rights and interests. However, each community can impose some norms or restrictions to their members. This case study illustrates how an *irrigator* agent which belongs to one *irrigation community* reaches an agreement on a contract with other agents, considering the existence of both norms imposed by the community and previous contracts.

Usually, irrigator communities forbid farmers to sell their production on their own, since they obtain better sale conditions if they sell their vegetables as a single entity (i.e. they do not compete among them):

$$n_i = \langle F, sell(Product, Buyer), Farmer,$$

$$pay(community, 1000), - \rangle$$

Therefore, if a farmer is caught selling his products on his own, then the irrigator community will punish him by paying 1000 euros ($pay(community, 1000)$).

In this situation, let us suppose that an agent (a) which is a farmer belonging to the irrigator community ($farmer \in Roles(a)$) wants to reach a contract with another agent (d) which is interested on buying vegetables.

According to the dialogue game protocol, the proponent agent (d) sends a contract proposition to the farmer agent a (Figure 2 Scenario 1 Message 1). Thus, n_c is a contract for

selling vegetables:

$$n_c = \langle O, sell(vegetables, d), a, d, -, pay(a, 5000), \rangle$$

According to this contract, if the farmer fulfils the contract, it would be rewarded by the distributor. More concretely, agent d would pay 5000 euros to the farmer if it sells its collected vegetables. Since agent a does not want to violate norms imposed by its community, then a rejects the contract (Scenario 1 Message 2). Then the proponent agent asks for more information about the rejection of the contract (Scenario 1 Message 3). In this case, the opponent agent shows argument $A1$ that claims that there is an institutional norm which forbids the contract conditions. More concretely, there is an institutional conflict $(IC(n_c, n_i'))$ since there is a substitution $\sigma = \{Product/vegetables, Buyer/d\}$ such us $unifies(sell(Product, Buyer), sell(vegetables, d))$. After observing the norm, the proponent poses and exception attack to this argument. Next, the opponent requests an argument for the exception attack (Scenario 1 Message 6). Then the proponent shows the evidence $(evidence_1)$ that the sanction imposed by the community is lower to the contract reward $(Des(pay(a, community, 1000)) < Des(pay(d, a, 5000)))$. Finally, agent a withdraws its rejection and accepts the contract (Scenario 1 Messages 8 and 9).

5 Discussion

The work presented in this paper proposes a new dialogue game protocol together with argumentation schemes for contract agreement inside dynamic VOs controlled by norms. Also, we show how argumentation schemes can be used to model the agents' reasoning over the acceptance or rejection of norms. Due to space reasons, the previous section describes the usage of our framework in a simple case study. In a near future, we plan to apply this approach into different case studies for evaluating its performance in practical situations.

Argumentation theory has been applied to MAS in several works. In [1], the formal representation of the procedural aspects of an argumentation protocol was proposed. The protocol distinguishes between constitutive rules, which define the protocol itself and the physical environment where it is executed, and the normative context that could make protocol actions obligatory or permitted. The main difference with our work is the external perspective adopted in this protocol. While they only take into account externally observable behaviours, we focus on the internal reasons that could make an agent to accept or deny a norm associated to a contract agreement process in a virtual organization. In addition, their protocol specifies actions that can be performed over propositions whereas our model determines the type of arguments that can be used to reject or accept norms.

In [6] a framework for conflict resolution in normative systems is presented. In this work, authors also adopt an externalist view, where agents present arguments to decide between executing an individual desired goal or observing an institutional norm. These norms are enforced through punishments and rewards modelled as the goals of enforcement agents that act as mediators in the dialogue. However, norms that emerge from interactions among agents are not considered.

On the area of norm negotiation, [2] presented a negotiation model for the acceptance of new social norms based on what they call the social delegation cycle. This model focuses on the emergence of norms in normative MAS, from the initial negotiation of social goals, to the final acceptance of their associated social norms when they fulfil the desires of the agents. This is considered as a social process, where agents collaborate to decide social norms. However, our model focuses on the formalisation of the individual arguments that can be exchanged between agents to persuade an opponent to accept an already existent norm.

A work that also proposes argumentation schemes to reason about norms was proposed in [7]. Unlike our model, this work focuses on the internal reasoning that an agent can perform in view of an internal normative conflict, taking into account priorities over norms, and the effects of these norms. On the opposite, our model is intended for virtual organizations, where several agents can argue about the individual acceptance or rejection of norms that other agents propose.

Finally, our protocol takes into account the internal reasons that could make an agent accept or deny a contract norm, but it may be argued that it is not a realistic assumption that the opponent will reveal its reasons for rejecting a contract proposal. However, we make this assumption in the basis that the agents really want to reach an agreement. Therefore, this agreement could hardly be reached if the agents are not willing to reveal their internal reasons to accept or reject a contract. This is the most reasonable way of finding an alternative that could fit the interests of both proponent and opponent agents.

ACKNOWLEDGEMENTS

This work was partially supported by the Spanish government under grants CONSOLIDER-INGENIO 2010 CSD2007-00022 and TIN2009-13839-C03-01, by GVA funds under PROMETEO 2008/051 project and by the FPU grant AP-2007-01256 awarded to N. Criado.

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